THE JOURNAL OF GEOGRAPHY

VOL. VII. MAY, 1909 No. 9

THE COLLEGE UNIT IN PHYSICAL GEOGRAPHY

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THE attitude of teachers and educators toward Physical Geography has undergone a great change since the time when men who are still relatively young studied it in their public school or college course. That was a time when practically no public school and few of the colleges were equipped for doing laboratory work in any subject. The small amount of laboratory work done even in the colleges and universities was confined to Chemistry and Physics with a certain amount of study of the simpler objects of Natural History.

Interest in a broader knowledge of the earth on which we live had been aroused by the published reports of the many scientific expeditions of the early and middle parts of the nineteenth century,—particularly those of Von Humboldt, Darwin, the Challenger and the Wilkes expeditions as well as the writing and teaching of the elder Agassiz and others of his associates. The interest and enthusiasm aroused was abundantly sufficient to have produced the most effective teaching of the subject had there been available a sufficient amount of material on which to base a course or series of courses in laboratory study. This, however, was almost entirely lacking. The studies of the earth up to that time had resulted in description merely. These dealt chiefly with the broader aspects of the earth's conditions and phenomena. Many of the descriptions were more or less ideal also. There was more or less attempt to describe the unusual, the striking, occasional and marvelous rather than the usual, everyday, common conditions that occur everywhere.

These described portions of the earth could not be brought into the

laboratory for study. The study up to that time had not produced any substitute for it. The teaching of the subject was necessarily book-teaching. The courses in the subject in all schools were text-book courses.

The shortcomings of this method were not generally recognized as long as most other subjects were taught in the same way. In the other Natural History subjects, however, especially in Zoölogy and Botany, the abundance and universal accessibility of the best laboratory material made it inevitable that these subjects should quickly and easily adapt themselves to laboratory study as soon as the teacher demanded it. Not so with Physical Geography, however. The necessity of some change in method of teaching it was soon recognized, but the inability to obtain the necessary material for laboratory study prevented the development of the subject along the same lines as Zoölogy. This produced a feeling of dissatisfaction and unrest among the teachers and especially among educators. The result was the abandonment of the subject by every one except those whose work lay close to it—by geologists. Public school men seemed to conclude that the subject could not be taught by modern laboratory methods and was not adaptable therefore to the school course.

That left the subject to those college and university professors whose work in Geology brought them into close sympathy with earth study as a whole.

Through the influence of these men the next stage in the development of Physical Geography teaching was reached. They were hampered greatly also by the lack of available laboratory material. The subject could not yet be developed on lines parallel with the other Natural History subjects. The necessity for doing something, however, was evident. It must be done also by men who were specialists in advanced scientific investigation—men who were accustomed to think in terms compatible with their chief lines of work, not by men who were specialists in teaching.

The investigator is concerned primarily with the systematic classification and with the explanation of facts. He must get facts, it is true, but this is a mere introductory, it is only the beginning and not the end of his effort. His thought is on explanation. The teacher of elementary science is concerned with the accumulation of a store of knowledge—of facts, not however in the dry cataloguing way in which we are accustomed to think of them, and in the development of methods and aptitudes for the still greater accumulation of knowledge in life. He studies these facts by means of simple comparisons and groupings, such as naturally follow from the association of the facts themselves, not from the standpoint of a theory

that has been developed on the basis of a broad knowledge of facts, and which cannot be understood until such broad knowledge has been accumulated.

His thought is on training in observation, clear-cut perception of objects or phenomena, comparison of objects and phenomena as knowledge of them is gradually accumulated and finally the grouping of the facts and phenomena thus accumulated in order to bring out relations. He is concerned, in this latter phase of his work, in enforcing the conviction that scientific conclusions are based, and must be based, on knowledge of facts and phenomena and are therefore necessarily tentative and are subject to change as long as there are new facts to be discovered. The teachers as a class were unable to develop the subject along these lines because of the lack of available laboratory material. They were unable, on account of lack of training, to develop it along any other lines. The professors of Geology were unable, both on account of lack of material and of the proper point of view, to develop it along the lines of simple elementary scientific training and accumulation of scientific knowledge. The teachers abandoned the subject. The professors undertook to develop it in their own way.

The result has been an emphasis on systematic classification of earth features and phenomena and attempts to explain facts by theory before the facts are known. The student has been taught to think of the earth in terms of a theory of earth development; to think of facts as mere illustrations of that theory; to think of the theory as something above and beyond and independent of the fact rather than as a conclusion drawn from a knowledge of the latter. They have been taught, consciously or unconsciously, to think the fact of no value unless it can be fitted into the theory and into the scheme of classification. Laboratory work has been emphasized, has been urged as an absolute necessity, but the laboratory has been used to illustrate a theory and a scheme of classification, not as a means of getting data and skill for building up the theory and the scheme of classification.

Such is the attitude taken at the present time not only by the university and college men, but through their leadership, by most school men. That is, it is unscientific in character. It is based on deduction rather than induction. The latter is the method followed in all the other Natural History sciences and it should be the method in Physical Geography. There is no longer any excuse for not doing so. Material has accumulated and is accumulating of the very highest

quality and the readiest accessibility for laboratory work. We must combine the attitudes of the two past stages in the development of the work and add to it the purely scientific method of induction based on abundant laboratory instruction. The old text-book study was deficient in quantity and intimacy of data and wrong in method of getting at it. The more recent deductive study is wrong in method and but little better in its presentation of data than the former. Its strong point is its attempt to rationalize the subject through its attempt at explanation—a most worthy object to have in view, but it fails to recognize that the preliminary to the solution of all problems is a clear statement of the facts and conditions. These cannot be stated until they are known.

Again dissatisfaction is being expressed by many teachers and educators both in the schools and in the universities and colleges. Many men and women are realizing that the present trend is not truly scientific and not adapted to the stage of development of the average high school pupil. The next step in the evolution of ideas about the teaching of the subject is about to be taken. It will be in the direction of more laboratory work, of laboratory work organized for the purpose of getting knowledge of the earth, of more study of the earth and less study of theories of the earth's evolution, of more accumulation of data and less attempt at explanation of data before it has been accumulated. In fine, a more intimate and thorough knowledge of the earth.

The Next Stage in the Development

What then is Physical Geography according to this coming view? What is Zoölogy? If asked to define Zoölogy not many of us would hesitate to say that it is the study of animals and animal life. What is Geography then? It is the study of the earth. I am aware that this definition is a broad one and includes Geology in its scope, but I do not desire to modify it because of that fact. The study of the earth necessarily includes the study of man and man's work in their geographic relations—such as location, communication, and interaction. The child's first study of Geography is a study of objects and their location. Throughout his course of study in the grades he is concerned, outside of his immediate home locality, with distribution or location of the broadest and most significant features of the earth both human and natural, organic and inorganic. He is concerned with those natural features that are broad, large and common to large areas. Aside from mere location, his study is concerned chiefly with the human side of the earth. He

acquires facts of human life that show the interaction of the earth and man, but rarely obtains a sufficiently close acquaintance of the earth's conditions to enable him to see the relation. Even if he did get enough facts on both the human and natural side to explain the interaction they could only be of the broadest kind.

Geography in the grades then concerns the broad general facts of the shape and relief of the surface of the earth, their location and distribution and the elementary facts of the distribution of man on the earth's surface.

Physical Geography should extend this study to include all the features on the earth's surface, organic and inorganic, and undertake more minute, careful, exact study of the features already studied in a general way. In other words, Physical Geography is Geography—is an extension of the work begun in the grades and concerns that body or organism, if you will, called the earth. It is not Physics, it is not Chemistry, it is not Biology, nor is it Botany. The pupil cannot concern himself with these subjects, if he is expected to obtain real knowledge of Physical Geography, in the short time allotted to that subject in the schools. He cannot do this even for the sake of the so-called explanation of facts of Physical Geography for several reasons. The first is that such explanations rarely explain to the immature mind of the pupil; a second is that he hasn't the time to pursue both Physics and Physical Geography in his course in Physical Geography and a third reason is that in elementary science the pupil is not primarily concerned with explanation. He is primarily concerned with methods of work, with observation, with collecting and comparing facts and not with the explanation of facts or phenomena. The ability to profit from explanations can come only with more mature minds and a greater grasp of essential facts than are at the command of the average high school pupil.

If we were to agree that the term "Physical Geography" is the name of a high school subject in general elementary science, then it would be permissible to include work in the subjects named above. I do not understand that the expression has any such meaning. One of the most common mistakes made by teachers of Physical Geography in the high schools of Missouri is to attempt too much so-called explanation of facts by reference to the principles of Physics and Geology. They incorporate such a large amount of elementary Physics and Geology into their laboratory work that little time is left for real Physical Geography. This has arisen through the ease with which simple experiments can

be made, in Physics especially. Teachers are trained also to teach Physics or some of the other sciences rather than Physical Geography, so that it is but natural that they would incorporate these things since they are forced to do some kind of laboratory work. They follow the line made the least resistant by their training. Such work is not Physical Geography.

Geographic facts and phenomena, or rather the facts and phenomena that occur on and in the earth, may be and usually are facts in other sciences. Many geographic facts are facts of Botany, of Physics, Chemistry, Astronomy, and of Zoölogy as well as of Economics, History and Sociology. What then is the difference? Is Physical Geography merely some artificial collection made from the realms of other sciences? Far from it—these facts and phenomena are as much a part of Geography when they are geographically treated as they are of Botany, or any other science, when treated from the several points of view of those sciences. They are geographically treated when they are considered from the points of view of distribution and of relation to each other. Distribution or position on or in the earth is an essential feature of Geography and many facts of Geography, physical as well as descriptive, do not become significant until they are treated from that point of view. For example, the structural and physiological phenomena of plants and animals are biological phenomena. The distribution of these things over the earth, their relation to other phenomena occurring on the earth, the laws controlling that relation, are geographic phenomena. The study of the character of a gas is Physics. The study of the distribution, pressure, movements, and effects of that particular gas called air, over the earth, is Geography. The teacher of Physical Geography studies the geographic phases of these things and assumes that their biological or physical phases are known or else merely states in as short a time as possible what these are. He is wasting his time, when he attempts to teach his class these things by laboratory experiment in order to "explain" his Physical Geography. The human mind, from its infancy as a race as well as that of the individual from his infancy to maturity, and beyond, has become accustomed to observe facts and wait for explanation until a fuller knowledge has been acquired.

Why do we include Physical Geography in our public school curriculum at all? The same stereotyped answer can and must be made to this question that is made to all such questions, to whatever subject in the curriculum they may apply. We are endeavoring to prepare the pupil for a life of use-

fulness to his fellow man and happiness to himself. The laws of economic life to a great extent and of social life to an important extent are more or less closely and indissolubly bound up with the laws of geographic adjustment and adaptation. These latter lead back directly to the laws of geographic evolution and the facts and phenomena existing on and in the earth. Such being the case, the goal of geographic study should be the construction in the mental consciousness of the student of so clear a picture of the whole earth that these laws and adjustments could be clearly seen and understood. This would include not only the facts of earth material, its arrangement and position, but the relations of these facts to each other, the laws governing such relations and the processes which work according to these laws. The picture should include not only the objects on the earth, their kind and distribution, but the relation of these to the interior of the earth, the forces that are at work and that have been at work to bring about such conditions as well as the stages passed through in the progressive evolution of existing conditions—a broad, comprehensive subject, evidently; one concerned to a considerable extent with at least one subject not ordinarily included as a part of Geography. No science, however, stands apart, isolated, with no roots or branches interlacing with others. In order to understand and unravel any one science, its interlaced science must be studied. This, however, be it remembered, is the final goal to be reached. It is the fruit of years of study along geographic lines and cannot be reached in one year by any known short cut even by mature men. The individual may never reach it, he may reach it through the university or college or he may reach it in the great school of life. One thing is certain, he cannot reach it in the high school.

The High School in its Relation to Physical Geography

What then is the function of the high school in this long course of training and increasing knowledge? What this ought to be can probably be best realized after a reference to the life of the pupil immediately after he leaves the high school. The close of the high school period is a point of divergence in the lives of the pupils. Some expect to enter the school of life. Others expect to enter college. Of those who enter college some expect to pursue studies that have no relation to their Geography work. Some expect to pursue the fundamental sciences on which rational Geography is based, while others expect to pursue humanitarian subjects, or as we might say, enter upon the subject of Applied

Geography. It is impossible to arrange several different courses in Physical Geography for the purpose of meeting the supposed requirements of each of these groups of students.

The high school cannot do otherwise than deal with those phases of the subject that are common to the diverging lines followed by all these pupils. Attempt to do otherwise divides and therefore wastes effort. The high school work, in Physical Geography at least, of the pupil who expects to enter college, should not be different from that of the pupil who expects to enter practical life. The work should be of such a fundamental character that it will be equally valuable as a training for life and as a requirement for college entrance. This will depend chiefly on the character of the work rather than on the things studied. In the selection of things to be studied the teacher should be guided by the requirements of the majority of the pupils, which usually are those who expect to enter practical life. To those who expect to enter college, the method of study rather than the things studied is the most important matter. To those who expect to enter life both are of importance.

The high school should develop the ability to observe geographic facts; a knowledge of the sources of geographic data and the ability to read it, ability to handle facts and to draw conclusions solely on the basis of the facts handled. It should avoid explanation by theory and follow the straightforward road to geographic knowledge without being led off on the many diverging ways or converging ways that lead toward the other sciences even at the risk of failing to explain many of the facts and phenomena of Geography. Explanation is not the principal business of the teacher of elementary science.

The High School Course

What then should a course in Physical Geography include? Physical Geography is a Natural History subject, one of a group of subjects that are investigated by observing what nature does under normal conditions rather than by creating artificial conditions and watching the result. It is an observational science rather than an experimental one.

The earth consists of three layers of material—at least that part of it that is open to observation—a gaseous layer, a liquid layer and a solid layer. There is, so far as I can see, no one exclusively logical order in which the study of these things should be taken up. It is a mere

matter of convenience or expedience. We have our subject grouped then under the three heads: The air. The water. The land.

Let us take them in this order. With what shall we begin our study of the air? While high school pupils have passed beyond that stage of mental development in which nothing can be understood unless it has a close relation to the pupil's experience, yet it should begin with some feature that can be observed.

A good plan is to start the work by asking some questions that can be answered by observation. The range of possible questions is very great. Every phase of the subject is connected with every other so that the chain of ideas connecting them will lead the student on from one to another more or less regardless of where a beginning was made. Suppose the class be asked what is the direction of the wind at the school locality. Suppose this be asked as a starter on the day the class meets for organization. Assign to them the matter of determining what changes in wind direction occur up to the time of the first meeting of the class for laboratory work. Naturally the question of the prevailing direction of the wind at that locality will arise, and by a simple process of reasoning the class can be led on to see that in order to determine this matter one of two things is necessary: the class must make daily observations extending over a long period of time, or they must have access to the records of observations that have been made in the past. The former is impossible as a high school class matter. The latter method is the only feasible means open to the high school class of determining the matter. This leads naturally up to the use of that kind of laboratory material that is an absolute necessity in Physical Geography. The nature of the object being studied and the time that can be devoted to it makes it impossible to handle the subject in any other way, except for a very few simple matters that may be determined by direct observation.

Have the weather charts at hand and place them in the hands of the pupils. Tell them nothing unless some of the conventional signs of the charts need explanation. Have each student tabulate the directions for one whole year, and draw his own conclusions as to the answer. Other questions, such as the relative velocity of the wind from the different directions and at different times or seasons of the year, would follow. This will doubtless suggest many other questions to the minds of the pupils. It will pretty certainly suggest the question of why the wind blows at all. This will simply have to be told to the class and it would be a waste of time to try to illustrate it by elaborate physical experiments.

Simply tell them that wind is moving air and that air flows from places on the earth where it is heavy to places where it is light. Illustrate by a heavy boy and a light boy pushing against each other.

In the meantime, having begun on the first day of school, have each pupil read the barometer, the thermometer, the wind and rain gauges, and keep the record tabulated in his note-book. Each pupil should keep, in addition, a daily record of the state of the sky. When you come to the question of why the wind blows ask for their conclusions as to whether the air is of the same weight at all times at any one place and have the conclusions drawn from their study of the daily weather charts. This will doubtless suggest to some one the question as to whether the weight of the air changes everywhere at the same time or whether it will be getting lighter in some places and heavier in others at the same time. This will lead to the study of the daily weather charts for this purpose and the definition of areas of light and of heavy air. Determine next, whether these areas are stationary, or whether they move. Then trace one, by means of consecutive maps, across the country. Follow this by determining and plotting the tracks of at least ten or more to determine the average track. This can be followed by the rate of movement, the rate by seasons, the intensity of the storms, or the difference between low and high pressure, the relation of wind direction and strength to these areas, the relation of rainfall to these areas as well as that of temperature, etc. It is unnecessary to go further. The teacher who is thoroughly imbued with the scientific method and knows his subject will know what to do. It should go on step by step to the general distribution of pressure and temperature over the earth, including the general winds.

At this point you come into close contact with the liquid layer of the earth. After having worked out the general winds of the world as a final object of that part of the course which deals with the air, take up the movements of the liquid layer. Study the relation of these movements to those of the air and have every student work out the similarities as well as differences. Study particularly such places as the Indian ocean and the Atlantic around the mouth of the Gulf of Mexico. Take up then the relations of these currents to the trend of isothermal lines on the earth and the great oceanic roadways. Discuss the relations of these air and water movements to the routes of sailing vessels and steam vessels on the Atlantic.

Follow this by a discussion of the tides. Avoid tidal theory. Have

each student plot the tidal curve for at least one place on the Atlantic and one on the Pacific through one month. Then after discussing one, compare them with each other and note similarities and differences. If the teacher is prepared to do so, he can then make the curves suggestive by placing on each curve the relative position, with respect to each other, of the earth, sun and moon for every fifth day. This is rather intricate work and should not be undertaken unless the teacher is thoroughly familiar with his subject.

The study of the tides will bring the pupil into close contact with the astronomical relations of the earth. This should be taken up but not a great deal of time spent upon it. It will be necessary to study the relation of the earth to the sun and moon in order to discuss the intervals between successive high tides, which will be brought out in the tide tables. The pupils will have had some astronomical geography in their grade work. This should be brightened up and they should be familiar with the structure of the solar system and its relation to the fixed stars, but bear in mind that it is not your business to teach astronomy. It is a subject that does not lend itself readily to inductive study. Very much attention paid to it is liable to develop the pupils' natural inclination to theorize.

These phases of the subject should be completed by the middle of the year. This should be the case whether the Physical Geography work is designed to cover one year or more than one year. By the end of the first half-year the pupil should be ready to begin the study of the solid layer of the earth. It is much more important because it is much more varied not only in itself but in its human relations as well.

Begin with a study of about a dozen common minerals and rocks, including those occurring in your neighborhood. This is a short study of the material of which the solid crust of the earth is made. Do not be led off into a study of Geology or Mineralogy, however interesting it may prove to be. Follow the material of which the crust is composed with the shape of the crust, in a broad way including the continents and ocean basins, the size, outline and position of the continents, their real boundaries, the relative positions of the great continents and ocean basins, the depths of the basins, shape of the bottoms and the relations of the different basins to each other. The general surface characters of the continents and their main drainage systems. Much of this phase of the subject will have been learned in the grades, but the live teacher will be able to bring out new features and relations by means of suggestive questions, all of which are to be answered by the pupil from his laboratory material—the relief maps of the world and of the continents.

The country that is to be studied in detail should be taken up next. This will be of course, for American students, the United States. Study a good relief map of the United States or rather have the students do it. It should be done by a series of well-directed questions drawn by the teacher with the map before him. Not a great deal of time need be spent on this phase of the subject. The general features will have become so well known to the pupils by this time that they will readily and quickly work out about all that can be more profitably learned from a general relief map than from a more detailed map.

A great geographer says that the final result of geographic study is the ability to make a map. By inference a knowledge of the earth sufficiently accurate and detailed to enable the possessor of such knowledge to make a map of it would be sufficient to make him a geographer or at least to earn for him the consciousness of knowing geography. Maps exist in all degrees of detail and accuracy. The more detailed and accurate the knowledge possessed by the map maker, the better will be his map. The knowledge of the world sufficient in quantity and quality to enable the possessor to make a map of it cannot be obtained by travel, by study of the actual object. The average mortal can not get his knowledge of the larger features of the earth from actual study of the earth, because of lack of time, of means and of ability. Even if he could study the whole earth he could not get a comprehensive idea of it until he had reduced his knowledge to a map. It is somewhat otherwise when we come to the study of detailed Geography, when we get down to the earth and study it close at hand rather than from a great height. Here the actual earth can and should be studied. In other words, some actual field study should be undertaken. Nothing can give more vitality to the work than a proper amount of field study properly carried out. It is, however, the most difficult part of the course to handle properly. The field excursions of an average class, especially if it be large and if the teacher has not obtained absolute control of his class, is almost necessarily a lark. It may be an excellent thing for the health of the class, but it does not increase their knowledge of Physical Geography to a great extent. In fact, I believe that if stated field excursions were almost completely abandoned, and individual work required of each student, much more would be effected. The object of field work is to train the pupil to observe and to make him familiar with the ordinary surface features within his range of direct observation. The student will gain both these results more effectually by going over the ground alone or with a very

few companions than he will if he goes in a large mixed crowd. The teacher can place in each student's hands a guide which will direct his observations to the proper channels. This can be done in the ordinary course of the pupil's movements about his home and on holidays.

The teacher must not, however, entertain false notions about the value of field work and its place in the course. It can occupy but a very short space of time and while it is important it is by no means the only important thing in the course. Field work becomes of increasingly greater value as the student progresses in his work, but in his first year of work he is not in the position to get the greatest profit from it.

We cannot bring the earth into the laboratory to study it, neither can the average mortal go over the whole of it or any considerable part of it for such purposes. The next best thing is to study some image or reproduction of it that can be brought into the laboratory. Such an image must necessarily be a reduced one rather than an enlarged one. Such images must be reduced in order that we may handle them, that we may get over the earth in our examination within a reasonable time, and in order that we may be able to see clearly the relations of various surface features to each other. Such images we call maps. While it is true that the map must be a reduced image of the earth's surface, yet there is a limit to the amount of reduction in size. That varies with the purpose for which the map is to be used. For the purposes of the average man, for the purposes of the teacher of Physical Geography in the school, the scale should be at least half an inch to the mile and for most places an inch to the mile. It is unnecessary, however, to say more about this matter. Every teacher of Geography is familiar with the maps now used for such purposes. I desire to add only this: the study of large-scale contour maps is absolutely necessary. It is one of the divisions of the course, one of the means of getting a clear-cut picture of the earth's surface features that cannot be dispensed with. This work should include from two fifths to one half the year's work.

From what point of view should this work be taken up? It will be impossible, within even half a school year, to study the whole earth or a whole continent or even one whole country. We must make a selection of areas to be studied. From what point of view shall the selection be made? Shall we select areas because in them are features that illustrate some theory of land form development? Shall we select them because they contain features that illustrate a prearranged classification of all possible land forms, based either on mere description or on some scheme

of development? To my mind such a selection of areas is wrong for two reasons: (1) It is unscientific and unnatural. Nature does not select objects for us to see merely because they illustrate nature's processes. (2) They give the student an entirely false notion of the benefits to be derived from the study of such areas. He is led to infer that the main thing is the theory of earth development or the classification and that these have been discovered in some other place. They have not arisen as conclusions based on study of actual earth features but have arisen intuitively, and that the earth exists merely for the purpose of illustrating man's inventive facilities. Furthermore, such a method is not geographic. It does not concern distribution nor relation to each other in position.

The study of any country should be taken up in a broad way at first to determine the nature and relative position of its main features and to give to the student the opportunity of making his own differentiation of the country into its main physical divisions.

In the study of the general map, of the United States for example, the student will be able himself, from his own individual observation of the map, to divide the country up into its main divisions. The position of the areas selected for detailed study should be located with respect to these divisions. That does not mean, however, that he should be made to deal with a classification not his own. Furthermore, the student's classification is geographic. The usual classifications in the average text are not geographic. They concern character rather than position. A classification based on land character is unintelligible before that character has become known by actual study. The working out of schemes of classification, or, in other words, the grouping of the facts of observation by the student himself, give the interest and inspiration that come from discovery and invention. The building up gradually, by the student, of his own scheme of classification is sound geographically, scientifically and pedagogically.

Areas for study should be selected because of their geographic importance. An area may be important from the point of view of human industry, another one important from the point of view of natural features alone. Areas of both kinds should be selected and studied and compared. Discussions as to why one area is occupied by man and the other not, or only sparsely so, are profitable so long as they deal with the facts, but are unprofitable when they pass beyond this, however valuable such discussions may be to more mature men and women.

Areas of importance from the human standpoint are those including

large cities—areas of human concentration. Take, for example, the area including Greater New York and the cities surrounding it. Others of value would be Philadelphia, Atlanta, Chattanooga, New Orleans, St. Louis, St. Paul, Chicago, Cleveland, Pittsburg, Kansas City, Denver, San Francisco, Salt Lake City, Seattle, Portland and Los Angeles.

How much of an area should be included? Certainly not less than twenty miles beyond the city limits on all sides and forty would be better. Such study should not be confined to areas of one map sheet. I mean the Standard Topographic Atlas Sheet of the United States. At least nine such sheets should be grouped together into one map.

What should be studied? Everything that the map shows. Begin with the mere descriptive geography—the position of things that are already more or less familiar, such as the towns, as well as the parts of the central city.

Take next the drainage and study by means of sketches made by the students. Its arrangement, the number and size of streams, as well as depth, if that can be determined. Follow with the topography. Work out the shape of the area on which the city actually stands, then the area of the surrounding country. Reproduce by memory sketches by the students. Generalize the topography, study relation of main features to the drainage, to agricultural occupation, to timber, to distribution of towns, to the positions of the railway lines. This latter should be worked out carefully. Are the railways local or parts of great systems? What are their termini? How do they enter the great city being studied? Do they reach its center or stop in the suburbs? If the city be a seaport, study the shape of the harbor, the depth of the water, the channels into it, the minimum depth at low water, at high water, the landing places with respect to the business center of the city. (Coast Survey Charts.)

It is not necessary to go further with this. After two or more cities have been studied they can be compared and many interesting relations brought out. The teacher who knows his subject will find the possibilities practically unlimited.

For areas selected for their natural features probably the most instructive area would be a long, rather narrow one, extending entirely across one or more of the great natural divisions of the country, such as the Appalachian region, another across the Rocky Mountain region. These should be located first with respect to their position in the United States, and in the main division of the country that is under consideration. They should then be studied from the simple observational standpoint. The

student should be required to do his own grouping of facts or classification and may be allowed to invent his own names. In this latter matter, however, he may be assisted by the teacher or by the literature or by both. He should never have the literature, if it be descriptive, until he has studied the country itself.

In case the class has time to study more than one area, others should be selected always from the point of view of geographic interest rather than from the point of view of geographic classification.

REVIEWS

APPLIED GEOGRAPHY—A Preliminary Sketch. By J. Scott Keltie; pp. 8+199. London, G. Philip & Son, 1908.

The second edition of Dr. Keltie's classic little book, appearing after an interval of eighteen years, is even more suggestive and helpful than was the original volume. The six chapters are entitled: Preliminary Considerations, Geography Applied to Commerce, The Geography of Africa in its Bearings on the Development of the Continent, The British Empire, Some Common Commodities, and The Unstaked Globe.

All the chapters are valuable for a teacher and full of suggestion to all who would know some of the more interesting phases of modern world geography.

The last chapter is, however, of the greatest interest in that it presents in simple and readable language some of the large political problems of modern times. It is interesting to note that the author's statement that England and France are both keeping "a watchful eye on Siam" has already been proven by the recent cession of certain provinces in Siam to the Malay States.

The book deserves to be read by all advanced students of geography in our normal schools and colleges, and will prove of value as a reference volume in secondary schools. R. E. D.

NAUTICAL CHARTS. By G. R. Putnam; pp. viii+162. New York, John Wiley & Sons, 1908.

Putnam's untechnical volume on Nautical Charts deals with the preparation, making and use of nautical charts, particularly those of the United States Coast and Geodetic Survey. One chapter includes a simple account of the most generally used projections and of the use of scales. The book is very helpful to the layman and to the teacher, and will help make interesting and practical the study of the ocean features.

The illustrations are numerous and well chosen, and the volume, though by no means complete in scope, is a timely aid for geographic work in education.

R. E. D.

APPARATUS FOR TOPOGRAPHIC FIELD WORK ON MODELS IN THE LABORATORY

By W. J. Mead and Lawrence Martin
University of Wisconsin

THIS apparatus, devised by Mr. Mead and constructed by Mr. E. H. J. Lorenz of the Geological Department of the University of Wisconsin, consists essentially of a rectangular frame supported at its corners by adjustable, telescoping legs so that by means of small spirit levels attached to the frame it may be oriented in a horizontal position on any part of an irregular topographic model. (Fig. 1.) Thus the stationary

Fig. 1. Showing the apparatus oriented in a horizontal position on an irregular model surface by means of the telescoping legs and the spirit levels

frame, being level, affords a plane of reference for measuring differences of elevation of points on the model. One end of a graduated bar, carrying a slide with a vertical pointer, is attached to a corner of the frame by a pivot, permitting the bar to move about that corner as a center. Thus the sliding vertical pointer may be readily moved to any part of the rectangle. The location of the pointer at any time is determined by (*a*) the position of the pointer on the bar, indicated in centimeters or in inches, and (*b*) the angular position of the bar, indicated in degrees by graduations on the rectangular frame. Vertical distances are measured by sliding the grad-

uated vertical pointer up and down, the number of feet being indicated by inches and tenths of inches.

To facilitate the recording of data, a drawing board of the same size as the rectangular frame is used, similarly graduated in degrees at the edge and carrying a graduated bar pivoted at one corner. A piece of paper, pinned to the board, corresponds to the rectangular area of the model within the frame, and locations and elevations may be readily transferred from the model to the paper. (Fig. 2.)

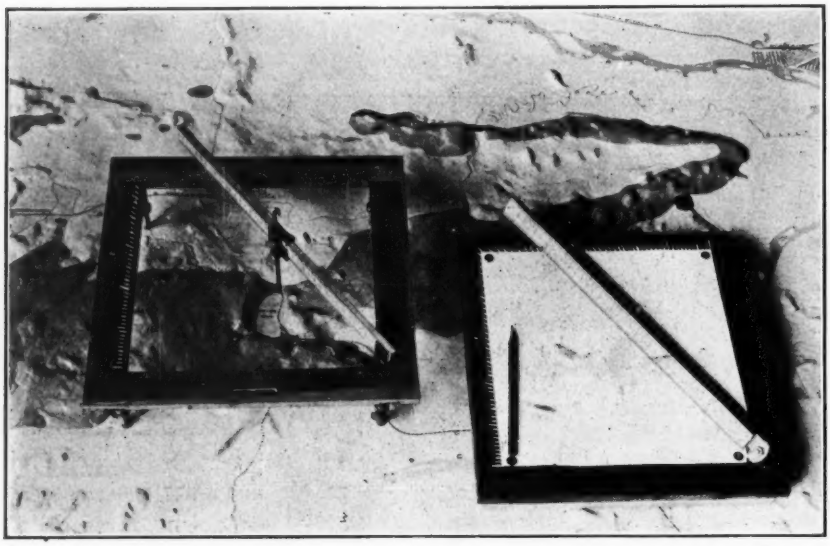

FIG. 2. Showing the rectangular frame and the drawing board. The graduated bar pivoted at the corner is similarly placed on frame and drawing board. By means of the slide and vertical pointer a map of Devils Lake on the Bareboo Model has been made and one contour partly traced

The chief use of such apparatus in physical geography and geography classes in schools and colleges is the making of topographic maps from significant parts of models and the making of small models of land from topographic maps. It is not intended in any way to replace the valuable initial exercises with models submerged in water which Professor R. S. Tarr at Cornell University[1] and Professor W. H. Hobbs at the University of Michigan[2] have made use of, graphically outlining the several contours

[1] "Representation of Land Forms in the Physiography Laboratory," JOURNAL OF GEOGRAPHY, VII, 1908, 73-85.

[2] "Apparatus for Instruction in Geography and Structural Geology," *School Science and Mathematics*, 1908; "New Laboratory Methods for Instruction in Geography," JOURNAL OF GEOGRAPHY, VII, 1909, 97-104.

and having each one drawn while marked by a water surface. Instead, it is thought that such apparatus may serve for detailed work later in the course. It may be said, however, that this accurate, rapid means of location might be applied to the method of either Professor Tarr or Professor Hobbs to some advantage, this polar coördinate system with the duplicate bar and drawing board saving the student some time. The rectangular coördinate system utilized by Professor Hobbs we have for a year and a half applied to the manufacture of large models at the University of Wisconsin and found very effective. For small models to be made from maps and for maps (contoured, hachured, geological, or geographical) to be made from models the polar coördinate system seems more advantageous. A map may be made either (*a*) by plotting all elevations along any given series of radiating lines or concentric arcs or (*b*) by setting the sliding vertical pointer at a given contour and locating the contour by angles and distances on the model while another student plots the data upon the map by the use of the duplicate bar. The apparatus may be constructed very cheaply, although not yet on the market. Its description here is presented as one of the methods of making laboratory work more precise while utilizing some of the model material available in the larger schools and in most colleges which make the subject more realistic and more interesting.

A QUESTION OF USAGE

The term topography, as generally employed by geographers in this country and by many teachers, has come to be practically the equivalent of surface features. This is due undoubtedly to the general use of the topographic maps of the United States Geological Survey. These maps are printed in three colors: brown, depicting the features of the land by contour lines; blue, depicting water features; and black, showing the features due to man's occupation of the area, except for canals and similar man-made water features. Black is, however, entirely devoted to what are commonly called the cultural features; any map from which the culture features are omitted is not called a topographic map. This is correct usage, for the word topography means the description of an area, and no area can be accurately mapped unless the culture features are shown. From the standpoint of accuracy, therefore, it is unfortunate that the word topography has come to be so laxly used, as a general thing, in our school work. Perhaps it is too late to change, but certainly is it not advisable to try to speak accurately especially in scientific work which, from its nature, is supposed to be accurate?

NOTES

THE SUMMER WINDS OF THE NORTH ATLANTIC OCEAN

The Atlantic Voyage.—No study of pilot charts or of text-books can give the clear understanding and appreciation of the great wind systems of the world which the traveler who takes an ocean voyage can secure by keeping his eyes open. In June, the month in which the writer started from New York, summer conditions are well established over the North Atlantic. The Pilot Chart shows that the dominant high-pressure area is somewhat to the southwest of the Azores, and covers the central and southern portions of the ocean. From this center, as is well known, the winds blow out spirally.

The Prevailing Westerlies of the North Atlantic.—To the north of the anti-cyclone their direction is generally from the southwest, and we have the *prevailing* or *stormy westerlies.* These are often interrupted by cyclones, which cause changes of wind direction to southeast or south with foul weather and rain, followed by a shift to the southwest and west or northwest with clearing weather and higher wind velocities. In these westerlies the pressure changes from day to day are irregular, and often reach 0.50 inch or more. The winds, while generally strong, are variable both in direction and velocity. During the colder months the storms increase in number and are more violent; the shifts of wind are more frequent; the periods of rainy and cloudy weather come oftener and the winds have higher velocities. Because the "Atlantic Ferry" runs through the latitudes of the stormy westerlies, the passage is apt to take a steamer through one or more storms, especially in the colder months. There are fewer changes in weather and in pressure on the eastward voyage than on the westward. This is because the storms themselves move eastward, and the steamer travels along with them. On the westward voyage the ship moves toward the approaching storms and in a given number of days is therefore likely to pass through more of such disturbances than when she travels eastward. On the westward voyage observer and storm approach one another at a rate equal to that of the westward velocity of movement of the steamer *plus* the eastward velocity of the storm. On the eastward voyage the rate of approach of observer and storm is equal to the difference of these velocities. The weather of the northern North Atlantic is characteristically boisterous, and the sea is apt to be rough.

The voyage across the latitudes to the south of the dominant anti-cyclone takes the traveler through very different conditions. Here the winds

blow from a prevailing northeast direction (the northeast trades) toward the equator. The trade winds blow over a region where the distribution of pressure is very uniform, and where the decrease of pressure with decrease of latitude is slight. Hence, these winds have a moderate but very constant velocity, and are remarkably steady in direction. The Pilot Chart shows clearly enough that the region of gales is in the northern part of the ocean, in the belt of prevailing westerly winds, while the trade wind latitudes are not subject to gales.

The first two or three days after leaving New York the weather may be unpleasant, especially in winter, but as the steamer takes a course very nearly southeast (passing to the west of Bermuda) until she is off Cape San Roque, she soon runs out of any temporary stormy conditions near the coast, and a day or two of fine weather, with generally light and variable winds, is encountered. In summer, calm sea and fine weather are likely from the start, with southwest winds for the first four or five days. These southwest winds are a part of the general spiral outflow from the permanent anti-cyclone near the Azores. They are clearly shown on the *Challenger* isobaric and wind chart for July, over the western portion of the North Atlantic. The Pilot Chart also shows them well in the "squares" around Bermuda. The steamer on which the writer was a passenger carried these southwesterly winds and fine weather for four days and a half after sailing from New York. The clouds were mostly of the cumulus type (cumulus, alto-cumulus, strato-cumulus), sometimes reaching cumulo-nimbus development in the afternoon and giving short, squally showers, but disappearing about sunset. The clouds came from about southwest throughout this time, except the cirrus which came from more nearly west. The lofty tops of the cumulo-nimbus were often observed to bend forward and topple over, dissolving as they descended below the level of previous condensation. This breaking off of the cumulo-nimbus tops frequently gave the remaining portion of the cloud a strato-cumulus appearance.

The Horse Latitudes of the North Atlantic.—The barograph curve showed a very steady rise after leaving New York, reaching its highest reading (30.25 inches) southeast of Bermuda, where the axis of the tropical high-pressure belt ("Horse Latitudes") was crossed June 23-24. The noon position on June 24 was latitude 26° 00′ north, longitude 60° 32′ west. The southwesterly winds noted above became very light and even failed altogether in this part of the voyage, and typical Horse Latitude calms were experienced. It was thus easy to see why this particular portion

of the ocean is avoided, when possible, by sailing ships. The old stories about vessels being becalmed in the Sargasso Sea and drifting around amid great masses of seaweed until they rotted away, were associated with these latitudes of the tropical calms. The diurnal variation of the barometer first became noticeable on June 22 and grew more marked with decreasing latitude, being a regular feature of each day's barograph curve during the remainder of the voyage and most marked near the equator. The temperature rose gradually as the ship went farther south, but remained under 80° during these first four days. The relative humidity averaged about 80 per cent. (D. B. 77.5°, W. B. 73.0°.)

The Northeast Trades.—Late on the afternoon of June 23 (noon position lat. 29° 46′ north, long. 63° 44′ west), during a calm, some fracto-cumulus clouds were observed coming from south 25° east, showing the presence of a wind from that direction at about a mile above sea level. In half an hour the northeast trade began to blow, at first from about south-east. On the following day the wind was fresh from east-southeast. It was noted that this wind began about 3° or 4° north of the northern limit of the northeast trade, as shown on the June Pilot Chart, but when the steamer was already in a "square" where east and southeast winds are shown to be prevalent. On June 24 (noon lat. 26° 00′ north) the charted "northern limit of the northeast trades" was reached. For six days the weather conditions were ideal. Fresh easterly winds blow day and night with just enough whitecaps to keep the sea from being "dead"; beautiful trade cumulus clouds, like our own summer clouds at home, but usually more delicate and much more slender, shine brilliantly in the tropical sun by day, growing larger in the later afternoon hours, when as cumulo-nimbus they often give brief showers, and fading away after glorious sunsets; temperatures never vary more than 2° or 3° above or below 80°, but one is perfectly comfortable owing to the fresh breeze and fairly low relative humidity (about 75 per cent.). Sailing under such conditions is certain to make even the most blasé traveler enthusiastic over the sea.

Short rain squalls, lasting five or ten minutes, were by no means infrequent in the northeast trades. These squalls were accompanied by a considerable freshening of the wind. In one case a slight, sudden increase in pressure was noted on the barograph curve, and a fall of temperature of 4° was observed at another time. Lightning was noted only once. Most of the showers came in the late afternoon, evening, and night. Fairly well-developed cumulo-nimbus clouds were not uncommon even in the early morning hours. This fact, together with the occurrence of showers at

night, suggests that radiation aloft, from the clouds themselves, is an important cause of atmospheric instability in these latitudes.

The pressure changes from day to day are very small in the trades. Storms are rare, and are limited to certain seasons. The voyager over these seas may therefore be sure of a succession of beautiful days, so much alike that he soon acquires the habit of the Tropics and stops talking about the weather. When day after day brings the same conditions, with which every one soon becomes familiar, to talk about the weather is as aimless as to greet every one with the exclamation, "The sun rose this morning!" In extra-tropical latitudes, where weather changes are frequent, the weather is naturally and will always remain a stock subject for conversation.

Several observations of flying-fish showed that these fish can remain above water a surprisingly long time. While the average duration of their flight was between six and eight seconds, it extended to eighteen seconds in one case. The sea during these observations was smooth. Over rough water, the duration of flight may be longer.

The Heat Equator.—On June 25 the sun was vertically overhead at noon. It was interesting to note that the maximum temperature recorded on the voyage (81°) was not reached until June 26, *i.e.,* farther south. This suggests the fact that the heat equator, in its migrations, lags behind the sun. As the steamer proceeded farther southward, the temperatures began to average somewhat lower and had fallen to 75° by the time Rio de Janeiro was reached. It was clearly seen that the temperatures within 5° or 10° north of the equator were somewhat higher than those the same distance south of "the line."

The Doldrums.—Throughout the six days during which the steamer was traversing the northeast trades, the wind was persistently from the east. The Pilot Chart for June shows that in these latitudes the prevailing wind is northeast, but that east winds are also frequent. In the summer of the Northern Hemisphere the northeast trades end between latitudes 5° and 10° north. The ship ran out of the northeast trades and into the doldrums at almost exactly the latitude indicated on the chart. The doldrum belt, with its characteristic heavy cumulo-nimbus clouds, its frequent heavy showers and squalls, its high temperature and damp air (relative humidity 80 per cent. or over), was crossed in about twenty-four hours. This indicates a width of 300 miles, more or less. The wind continued from the east during much of this time, but was often interrupted by calms.

Cloud Movements in the Doldrums.—Much interest attaches to the directions of cloud movement in the doldrum belt, because of their bearing

on the theory of the general circulation of the atmosphere. On June 29, at 2:30 P.M. (noon position, lat. 8° 46′ north, long. 44° 47′ west) cirrus was observed coming from the east, cirro-cumulus from east 20° south, and fracto-cumulus from the southeast, the wind being from the east. At 3 P.M. cirrus and cirro-cumulus were observed moving from the east. The east-west drift near the equator is here clearly indicated. These observations were taken near the southern limit of the northeast trade. On June 30 (lat. 5° 26′ north, long. 41° 21′ west) cirrus was noted coming from east 10° south, the vessel being then in the doldrum calms. The transition from doldrums to southeast trade was gradual, at about latitude 4° north. The lower clouds came from the southeast before the wind began to blow from that direction. In latitude 2° 39′ north, longitude 37° 39′ west, alto-cumulus was observed coming from southeast by east, and also from east 10° south.

The Southeast Trades.—For six days more, nearly to Rio de Janeiro, the delightful trade-wind conditions already described were again experienced; six days more of ideal temperature, wind, sea and sky, where simply to sit on deck is unalloyed satisfaction, and where, with the fresh, balmy trades blowing into one's open door and port-holes, sleep comes readily to those who, when ashore, dread the wakeful hours of the night. No high clouds were noted in the southeast trades. On July 3 the "green ray" was seen at sunset. The sun went down behind a heavy mass of trade cumulus, but the base of these clouds was about 10° above the horizon, so that the whole disk of the sun was visible as it set. After passing Cape San Roque the steamer's course took her not far offshore and it was noted that showers became more frequent. This is a characteristic phenomenon on windward coasts in the trades. Pernambuco, it will be remembered, has winter rains. It was also observed that near land the trades were less steady in direction. The development of heavy cumulus clouds over the land was clearly shown.

These same conditions were noted in these waters on the return voyage. After passing the northern tropical high-pressure belt, the barograph curve showed a general fall until the doldrums were reached, when a gradual rise began again as the steamer proceeded southward. The diurnal variation continued well marked, but less regular as higher latitudes were reached. The last day before reaching Rio de Janeiro the wind was northwest off the land.

—From *Monthly Weather Review,* October, 1908.